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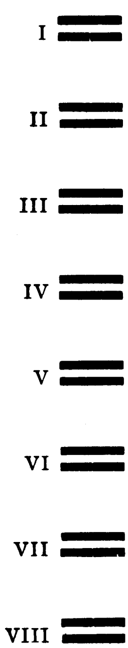
A METHOD FOR DETERMINING THE SCREW-ERRORS OF A ZENITH-TELESCOPE.

By Frank Schlesinger.

The zenith-telescopes in use at the four principal stations of the International Geodetic Association for Observing Variations in Latitudes are each accompanied by a double meridian-mark. By means of these, the adjustment of the azimuth-stops becomes a very simple matter and may be effected every night if necessary. In order to focus upon the marks, an auxiliary lens has been placed between the objective and ocular, and as near the latter as possible. This lens can be shunted into the optical axis whenever the meridian-marks are to be viewed; at other times it rests well to one side of the axis. This arrangement has suggested a method for examining the micrometer-screw, which has been tried at Ukiah with satisfactory results.

In the present case the meridian-marks are 55.5 meters (182 feet) north of the telescope; upon the small structure which serves to shelter them was fastened a vertical scale divided into seven nearly equal spaces. Each of these spaces was of such a length as to correspond approximately to one revolution of the micrometer-screw when the auxiliary lens was in position. The total length of the scale was actually 130^{mm}, each space being about 18.5^{mm}. It is not necessary in the method to be described that the scale be accurately divided. It was found that an entirely adequate scale could be ruled on drawing-paper with india-ink, like the one shown in the accompanying sketch. The division-marks were made double, and could be nicely bisected by the single thread of the micrometer. The screw has an effective length of twenty-eight revolutions. As it would be impractical to examine the whole screw at once, it was divided into four equal portions, and each of these was investigated separately. The method used to do this is an adaptation of that developed by Gill, Lorentzen, and others. A clear account of this method is given by Professor Harold Jacoby in the *American Journal of Science* for May, 1896.

The micrometer having been set at about $1^{R}.0$, the telescope was pointed so that the micrometer thread coincided as nearly as possible with Division VII of the scale. Readings were made



upon this division, and also upon Division VIII, care being taken not to move the telescope between the two sets. The micrometer having been set back to $1^{R}.0$, the telescope was pointed at Division VI. Readings were then taken on Divisions VI, VII, and VIII. In this way the operations were continued until each space of the scale had been measured with each turn of the micrometer from $1^{R}.0$ to $8^{R}.0$. These measures furnish data from which the errors of both screw and scale can easily be computed. The three other parts of the screw were treated in an entirely similar manner; so that it only remained to determine the errors at 8^{R}, 15^{R}, and 22^{R}. This was done by measuring the total length of the scale with the four parts of the screw in succession. Throughout the work all operations were immediately repeated in reverse order, to provide as far as possible against changes in the telescope, in the observer, or in the scale.

Such an investigation as has been described was made at Ukiah and repeated until at least four determinations of each screw-error had been obtained. A comparison of the separate results gives only 0″.025 for the probable error of a single determination. I give below a list of the definitive corrections. It will be noticed that they are small and that they run very smoothly, there being no abrupt change except at the extreme end of the screw. The units are hundredths of a second:—

R.	Corr.	R.	Corr.	R.	Corr.	R.	Corr.
1 ...	− 1	8 ...	+ 4	15 ...	+ 2	22 ...	+ 3
2 ...	0	9 ...	+ 4	16 ...	− 2	23 ...	− 3
3 ...	− 5	10 ...	+ 5	17 ...	− 1	24 ...	− 4
4 ...	− 4	11 ...	+ 5	18 ...	− 2	25 ...	− 8
5 ...	− 4	12 ...	+ 4	19 ...	− 2	26 ...	− 8
6 ...	− 3	13 ...	+ 2	20 ...	− 2	27 ...	− 5
7 ...	+ 1	14 ...	+ 2	21 ...	+ 2	28 ...	+ 4
						29 ...	+ 12

If it be desired to use this method for determining the periodic as well as the progressive errors, a scale should be used whose total length corresponds to one turn of the screw and which is divided into four or five equal parts.

The auxiliary lens is not strictly necessary, as the vertical scale may be brought into focus by drawing out the ocular. In this case, however, it is not advisable to examine the screw concurrently with the latitude-observations, as the constants of the instrument are liable to disturbance.

The method which has been almost exclusively employed for determining the screw-errors of a zenith-telescope is that afforded by elongations of close circumpolar stars. The weak point in this method is the dependence upon the latitude-levels. A complete elongation of *Polaris* or of λ *Ursæ Minoris* occupies more than an hour for a telescope with a field of twenty minutes of arc. Latitude-levels, even under favorable circumstances, cannot be depended upon to maintain a constant angle with the telescope for so long a time. Moreover, during an elongation the observer must remain at one end of the levels — just the position in which the heat from his body is likely to warp them. It is this circumstance probably, to which are due the inaccurate results sometimes obtained by the method of elongations.

In his "Anleitung zum Gebrauche des Zenitteleskops" (Berlin, 1899), Doctor ALBRECHT has recommended the use of an auxiliary micrometer, to be fixed at the eye-end of the telescope. The errors of both screws can thus be determined simultaneously. In this method the optical system during the examination of the screw is entirely different from that used for the latitude observations, and slight systematic errors may creep in. This objection also applies, but in a lesser degree, to the method of this paper. The latter has the additional advantages of greater convenience and in requiring practically no auxiliary apparatus.

INTERNATIONAL LATITUDE OBSERVATORY,
Ukiah, California, 19 November, 1901.

PLANETARY PHENOMENA FOR MARCH AND APRIL, 1902.

By MALCOLM McNEILL.

MARCH.

The Sun crosses the equator from south to north on March 21st, 5 A.M., Pacific standard time.

Mercury is a morning star, and comes to greatest west elongation on March 17th. Although its distance from the Sun at this